

FILE B

Science and Technology:

**Item Information and Scoring Guide Reference
Sheet and Quantities of Items by TypeB-2**

Item Information and Scoring Guide
Reference SheetB-3

Quantities of Items by TypeB-4

**Items with Keys, Learning Results, Scoring Guides,
Training Notes, and Student ResponsesB-5**

[Back to Table of Contents](#)

Science and Technology

Item Information and Scoring Guide Reference Sheet and Quantities of Items by Type

Item Information and Scoring Guide Reference Sheet

The following pages are designed to assist you in understanding how Maine Educational Assessment (MEA) items are scored. These pages contain the text for each item accompanied by the following information.

- **MC#:** the multiple-choice item position
- **Key:** the letter of the correct answer for the multiple-choice item
- **Learning Results:** the content standard, followed by the performance indicator, that the item measured
- **CR#:** the constructed-response item position
- **Learning Results:** the content standard, followed by the performance indicator, that the item measured
- **Constructed-Response Scoring Guide:** the four-point description used to determine the score
- **Training Notes:** in-depth descriptions or particular information used to determine the score

MAINE 2002–2003

Science and Technology Grade 11

The table below shows the quantities of released items for each item type. Item information for all item types and scoring information (guides and training notes) for all constructed-response items follow.

QUANTITIES OF ITEMS BY TYPE

MC	CR
24	6

**Items with Keys, Learning Results, Scoring Guides,
Training Notes, and Student Responses**

1. Which product would likely cause the **most** environmental problems if placed in a landfill?
 - A. newspaper
 - B. aluminum can
 - C. battery
 - D. plastic container

MC#: 1

Key: C

Learning Results: M-2

Implications of Science and Technology

- M Students will understand the historical, social, economic, environmental, and ethical implications of science and technology. Students will be able to
- 2 demonstrate the importance of resource management, controlling environmental impacts, and maintaining natural ecosystems.

2. Lenses such as those in telescopes and microscopes depend on which property of light?
- A. refraction
 - B. diffraction
 - C. interference
 - D. polarization

MC#: 2

Key: A

Learning Results: H-2

Energy

H Students will understand concepts of energy. Students will be able to
2 examine and describe how light is reflected and refracted (deflected) by mirrors and lenses.

3. In today's atomic models, what accounts for most of the volume of an atom?
- A. electrons
 - B. protons
 - C. neutrons
 - D. empty space

MC#: 3

Key: D

Learning Results: E-1

Structure of Matter

- E Students will understand the structure of matter and the changes it can undergo. Students will be able to
- 1 trace the development of models of the atom to the present and describe how each model reflects the scientific understanding of its time.

4. The nitrogen cycle is important to all living things because nitrogen is found in which molecules?
- A. saturated fats
 - B. nucleic acids
 - C. starches
 - D. sugars

MC#: 4

Key: B

Learning Results: B-1

Ecology

- B Students will understand how living things depend on one another and on non-living aspects of the environment. Students will be able to
- 1 illustrate the cycles of matter in the environment and explain their interrelationships.

5. Scientists think that life on Earth began with one-celled organisms when Earth's atmosphere consisted of some or all of the following gases: methane, ammonia, water vapor, hydrogen, carbon monoxide, carbon dioxide, and nitrogen. Which must have been a characteristic of these organisms?
- A. cells that had a definite nucleus, but very few other cell structures
 - B. cells that carried out respiration without oxygen
 - C. cells that used sugars as the genetic code instead of DNA
 - D. cells that carried out photosynthesis without light

MC#: 5

Key: B

Learning Results: D-6

Continuity and Change

- D Students will understand the basis for all life and that all living things change over time. Students will be able to
- 6 analyze a theory scientists use to explain the origin of life.

6. What do scientists assume to be generally true when they gather and interpret data about stars other than the Sun?
- A. All stars are the same size as the Sun.
 - B. All stars are the same distance from Earth.
 - C. All stars are the same temperature as the Sun.
 - D. All stars are composed of elements found on Earth.

MC#: 6

Key: D

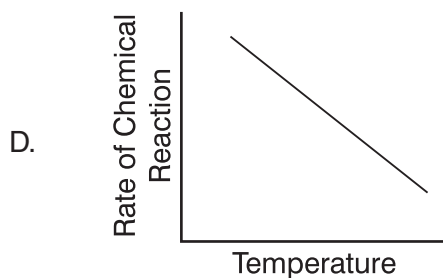
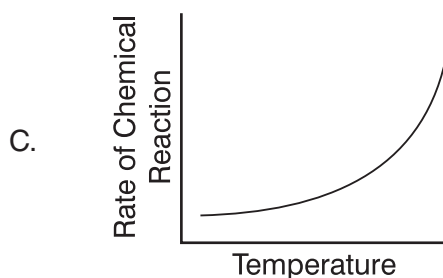
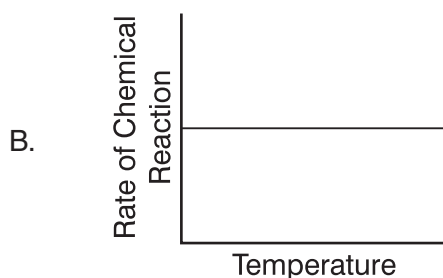
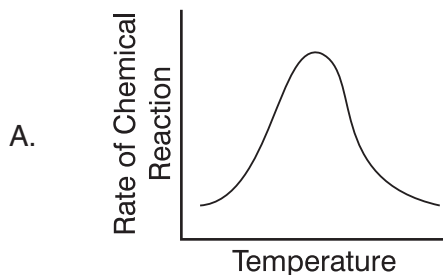
Learning Results: G-1

The Universe

- G Students will gain knowledge about the universe and how humans have learned about it, and about the principles upon which it operates. Students will be able to
- 1 describe how scientists gather data about the universe.

In the human body, the enzyme pepsin helps break down proteins to amino acids. Pepsin is most effective around 37°C. A student plans to conduct an experiment by placing the same amount of pepsin in beakers containing a protein solution that is at various temperatures ranging from 10°C to 50°C.

7. Which graph **best** illustrates the expected results for this investigation?



MC#: 7

Key: A

Learning Results: L-4

Communication

L Students will communicate effectively in the application of science and technology. Students will be able to
4 employ graphs, tables, and maps in making arguments and drawing conclusions.

8. In long-exposure photographs taken at night, the stars appear as curved lines rather than as single points. This observation is evidence that
- A. the stars orbit our galaxy.
 - B. the stars are moving away from our galaxy.
 - C. Earth rotates on its axis.
 - D. Earth revolves around the Sun.

MC#: 8

Key: C

Learning Results: G-1

The Universe

- G Students will gain knowledge about the universe and how humans have learned about it, and about the principles upon which it operates. Students will be able to
- 1 describe how scientists gather data about the universe.

Two Theories of How
the Moon Was Formed

1. The “great impact” theory suggests that a celestial body hit Earth’s surface. Molten material then flew off into space, was caught by Earth’s gravity, and formed the Moon.
2. The “capture” theory suggests that a passing body was captured by Earth’s gravity. This body then began to orbit Earth as its moon.

9. Which piece of scientific evidence best supports the “great impact” theory?
- A. The Moon’s orbit is not directly above Earth’s equator.
 - B. Newton’s law of universal gravitation explains the Moon’s orbit.
 - C. The Moon’s composition is similar to that of Earth’s outer layer.
 - D. The same side of the Moon always faces Earth.

MC#: 9

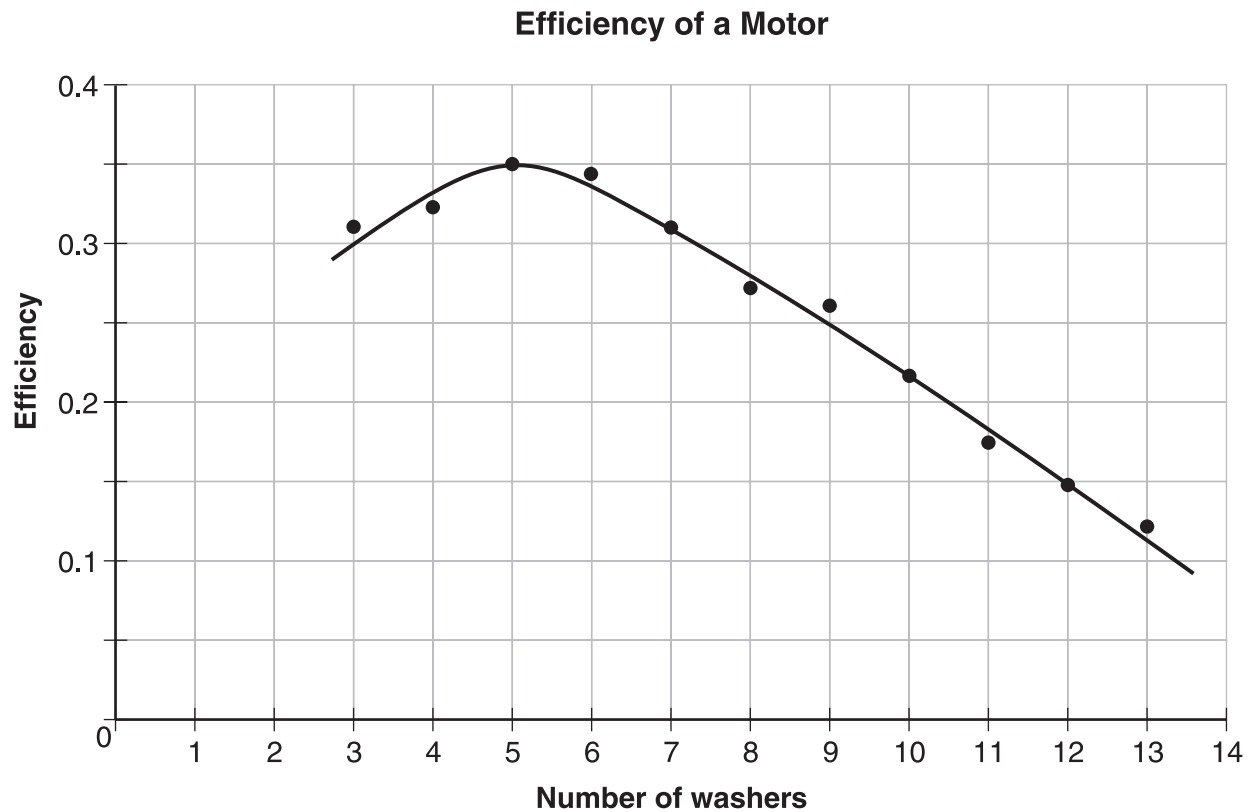
Key: C

Learning Results: K-1

Scientific Reasoning

K Students will learn to formulate and justify ideas and to make informed decisions. Students will be able to
1 judge the accuracy of alternative explanations by identifying the evidence necessary to support them.

The graph below shows the efficiency of a small motor as it lifts washers a distance of 2 meters.



10. Which statement is **best** supported by the graph?
- A. The motor's efficiency when lifting 8 washers is greater than when lifting 5 washers.
 - B. The motor's efficiency when lifting 3 washers is about the same as when lifting 7 washers.
 - C. The motor's efficiency increases as more washers are lifted.
 - D. The motor's efficiency is not related to the number of washers lifted.

MC#: 10

Key: B

Learning Results: L-4

Communication

L Students will communicate effectively in the application of science and technology. Students will be able to
4 employ graphs, tables, and maps in making arguments and drawing conclusions.

11. Which would most likely decrease the rate of photosynthesis?
- A. an increase in the amount of water
 - B. an increase in the amount of light
 - C. a decrease in the amount of carbon dioxide
 - D. a decrease in the amount of oxygen

MC#: 11

Key: C

Learning Results: B-2

Ecology

- B Students will understand how living things depend on one another and on non-living aspects of the environment. Students will be able to
- 2 compare the processes of photosynthesis and respiration, and describe the factors that affect them.

12. What is produced when an acid reacts with a base?
- A. nitrogen and hydrogen
 - B. carbon and hydrogen
 - C. a sugar and water
 - D. a salt and water

MC#: 12

Key: D

Learning Results: E-3

Structure of Matter

E Students will understand the structure of matter and the changes it can undergo. Students will be able to
3 describe the characteristics and behavior of acids and bases.

There are various hypotheses as to why dinosaurs became extinct. The meteorite hypothesis links the extinction to a meteorite colliding with Earth. The volcanic activity hypothesis associates the extinction with an increase in volcanic eruptions.

13. The discovery of a large crater (several miles across) that formed on Earth 65 million years ago could be used as evidence to support which of these hypotheses?
- A. only the meteorite hypothesis
 - B. only the volcanic hypothesis
 - C. both hypotheses
 - D. neither hypothesis

MC#: 13

Key: A

Learning Results: K-1

Scientific Reasoning

K Students will learn to formulate and justify ideas and to make informed decisions. Students will be able to
1 judge the accuracy of alternative explanations by identifying the evidence necessary to support them.

14. Which type of molecule is important in forming the strong, elastic fibers found in muscles?
- A. fats
 - B. sugars
 - C. starches
 - D. proteins

MC#: 14

Key: D

Learning Results: C-3

Cells

- C 3 Students will understand that cells are the basic units of life. Students will be able to discuss the function of the important “molecules of life”—proteins (including enzymes and hormones), carbohydrates, lipids, and nucleic acids.

15. Which of the following is the primary element used in semiconductors?

- A. silicon
- B. hydrogen
- C. nickel
- D. potassium

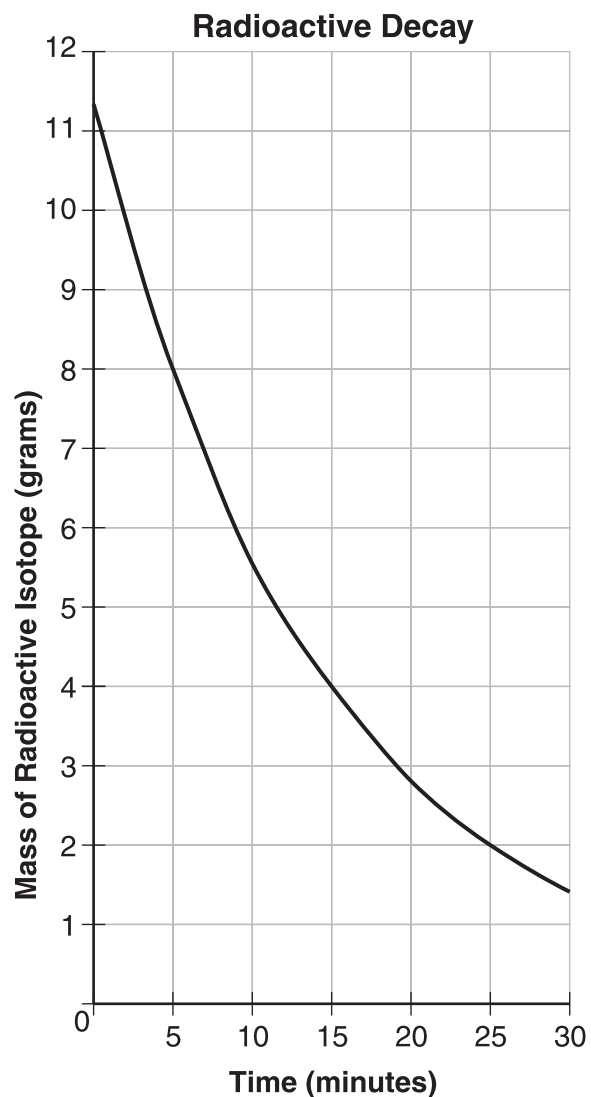
MC#: 15

Key: A

Learning Results: H-8

Energy

H Students will understand concepts of energy. Students will be able to
8 compare and contrast how conductors, semiconductors, and superconductors work and describe their present and potential uses.



16. The half-life of a radioactive isotope is the time it takes for half of the isotope to decay. About how long is the half-life of the radioactive isotope that yielded the data shown in the graph?
- A. 5 minutes
 - B. 10 minutes
 - C. 15 minutes
 - D. 25 minutes

MC#: 16

Key: B

Learning Results: L-4

Communication

L Students will communicate effectively in the application of science and technology. Students will be able to
4 employ graphs, tables, and maps in making arguments and drawing conclusions.

Amount of River Pollution	Average Concentration of Dissolved Oxygen in the River (in parts per million)		Typical Organisms Found in the River
	(5°C)	(15°C)	
none	7.7	5.3	mayfly nymph, salmon, trout
little	6.3	4.2	caddis fly larva, crayfish
some	4.8	3.3	water louse, bloodworm, leech
a lot	1.7	1.2	mosquito larva

17. Which generalization is **best** supported by the information in the table?
- A. As the pollution of a river increases, less oxygen is dissolved in the water.
 - B. As the temperature of a river increases, more oxygen is found in the water.
 - C. Pollution of a river has only a small impact on the types of animals found in the water.
 - D. Pollution of a river causes the temperature of the water to increase.

MC#: 17

Key: A

Learning Results: K-3

Scientific Reasoning

K Students will learn to formulate and justify ideas and to make informed decisions. Students will be able to
 3 develop generalizations based on observations.

18. Which process causes variation among the organisms within a species?
- A. binary fission
 - B. polyp formation
 - C. sexual reproduction
 - D. asexual reproduction

MC#: 18

Key: C

Learning Results: D-2

Continuity and Change

- D Students will understand the basis for all life and that all living things change over time. Students will be able to
- 2 describe why the offspring of sexually reproducing species have different survival rates than those of asexually reproducing species under a variety of conditions. Describe the advantages and disadvantages of each.

19. Which of the following produces wind?
- A. the movement of Earth through space
 - B. the Moon's gravitational pull
 - C. the buildup of opposite electric charges in the atmosphere
 - D. the uneven heating of the atmosphere

MC#: 19

Key: D

Learning Results: F-1

The Earth

F Students will gain knowledge about the earth and the processes that change it. Students will be able to
1 describe how air pressure, temperature, and moisture interact to cause changes in the weather.

20. It snows a lot in the upper elevations of Washington, Oregon, and Utah. Which type of air mass causes this condition?

- A. cold and dry
- B. cold and humid
- C. warm and humid
- D. warm and dry

MC#: 20

Key: B

Learning Results: F-1

The Earth

F Students will gain knowledge about the earth and the processes that change it. Students will be able to
1 describe how air pressure, temperature, and moisture interact to cause changes in the weather.

21. Various diseases (such as polio, measles, and tuberculosis) occur today at a much lower rate in the United States than in the past. However, these same diseases still occur at a high rate in some countries.
- Discuss **two** technological imbalances that cause this difference in disease rate.
 - Explain **two** ways that the high disease rate in some countries could be lowered.

CR#: 21

Learning Results: M-6

Implications of Science and Technology

M Students will understand the historical, social, economic, environmental, and ethical implications of science and technology. Students will be able to

6 research issues that illustrate the effects of technological imbalances and suggest some solutions.

CONSTRUCTED-RESPONSE SCORING GUIDE

Score	Description
4	Response demonstrates a thorough understanding of the effects of technological imbalances. Response completely discusses two technological imbalances that cause differences in disease rate and two ways the disease rate could be lowered.
3	Response demonstrates a general understanding of the effects of technological imbalances. Response broadly discusses technological imbalances that cause differences in disease rate and how the disease rate could be lowered. Response contains minor errors or omissions.
2	Response demonstrates a simplistic understanding of the effects of technological imbalances. Response partially discusses technological imbalances that cause differences in disease rate and/or ways the disease rate could be lowered. Response contains major errors or omissions.
1	Response demonstrates little understanding of the effects of technological imbalances. Response discusses a technological imbalance that causes differences in disease rate or a way the disease rate could be lowered. Response is minimal.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.
Blank	No response.

Training Notes for Constructed-Response #21

- a. As a starting point, try to assign 1 point for each technological imbalance **discussed** (maximum of 2 points). Technological imbalances may be in sanitation, hygiene, vaccines, antibiotics, and exposure to environmental conditions including exposure to the disease-causing organisms. Simply listing two of these is only worth 1 point.
- b. As a starting point, try to assign 1 point for **explaining** each solution to the high disease rate (maximum of 2 points). Solutions might be education, prevention by avoidance, getting vaccinated, ways of decreasing the population of the disease-causing organism, exporting technology from the United States, improving sanitation and hygiene, etc. Simply listing two of these is only worth 1 point.

Note: For part a, population or economic differences are not acceptable answers by themselves—they must be tied to some technological imbalance.

21.

4

a. One, the United States' economy is much higher than that of third-world countries. Hence, we have more money to spend on vaccines and disease prevention and treatment. Many third world countries are barely equipped with hospitals. Two, our country is very careful about sanitation and cleanliness. We have the knowledge and wealth to keep equipment used in hospitals and doctors' offices sterilized so that diseases won't spread. Some third-world countries don't even realize that not being sanitary could spread these diseases.

b. One, spread awareness and products for birth control, in the case of STD's. Although this may not be quite as life-threatening as TB and polio, this is important too. Not only could it affect all the person's partners if infected, but it could also spread to their children. Two, missionaries with medical degrees or simply doctors and nurses could go to the high-disease-rate countries and help administer medical care for those diseases, including antibiotics, vaccinations, and pamphlets on the disease itself for future prevention.

② One technological imbalance is in America we have the money for research on these diseases and how to get rid of them, in other countries that is impossible. Another imbalance is the development of the country. Some countries people don't have running water or proper sewage treatments. These things can spread diseases fast along with the lack of medicine for the poorly. ③ One way to lower the disease rate is to help the under developed countries with proper education and mechanical skills to get proper sewage treatment and running water systems. Another thing is to give them vaccines and medicines to prevent diseases and to train nurses over in their country.

a. The difference in disease rate between the U.S. and some countries is due to lack of medical technology and lack of good sanitation. Some countries are so poor they can't afford the technology the U.S. has and therefore go without. Good sanitation is next to impossible because there are almost no means to get rid of waste and garbage. This results in a breeding ground for bacteria and viruses. The high disease rate can be lowered by providing these countries with more money to afford medical equipment and better sanitation. Educating ^{the countries} about the dangers of poor sanitation is another way to lower the high disease rate.

A. Technological imbalances are very much the reason for higher disease rates in some countries. Two obvious imbalances which add to this differential rate issue are money and knowledge. Countries with a higher disease rate either don't have the money to buy such equipment ~~as~~ medicine to prevent disease, or they don't have the knowledge needed to look into people's benefits. Some countries are so unimproved that it's causing them their health.

B. Considering the reasons as to why disease rates are so high, it's easy to see how they can be lowered. Countries which do have high disease could look into informing their public, provide information of what people can do to prevent such harm to themselves. Another way to lower their rate would be to seek financial help, which could help provide them with needed materials and so forth to decline spreading ~~or~~ medicine for cures.

21.

2

we have much more advanced medical technology than some countries, and this shows when the disease rates are compared. Other countries may have doctors, but maybe no doctors who are equipped with such good medical advances as we are. I think that if we help other places, and fill them in on our research and technology, then that would help lower their disease rates. If they had a better food and water supply, that wasn't contaminated, then I think that would help to lower it also.

21.

2

A technological imbalance that causes this difference in disease rate is the knowledge of the diseases and the amount of doctors who are on-hand and knowledgeable. Another technological imbalance that causes this difference in disease rates is the medical treatment provided. Prescriptions of drugs may not be available in a certain country. High disease rates could be lowered by giving medical treatment to the patient when there has been a first sign of the disease. High disease rates could also be lowered by demanding visits to a doctor or healthcare specialist every so often.

21.

1

A. he have beter ways to treat people
and Scientists to figure it out.

B. by getting funds for research and
info on treatment and prevention.

21.

1

A) We now a days have better technology
and understanding of the diseases and
we most likely have a cure for them. Back
then they didn't know as much about the
disease so they could not cure it.

B) If the other countries knew more
about it and how to cure it. If
they knew how the disease worked
and they had a better understanding
of the disease.

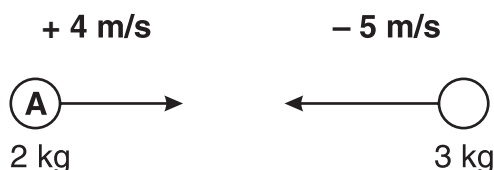
An object's momentum is mathematically defined as the product of its mass and its velocity.

$$\text{momentum} = \text{mass} \times \text{velocity}$$

or

$$p = mv$$

Momentum is a vector quantity; that is, to fully describe momentum you must give a number with appropriate units of measure **and** a direction. When determining the total momentum of colliding objects, the direction of the objects must be taken into account.



22. These two spherical objects are about to collide as they travel along a straight line. A positive sign is used to represent one direction along the line and a negative sign is used to indicate the opposite direction along the line.
- What is the momentum of **object A** before the collision?
 - What is the **total** momentum of the two objects before the collision?
 - If the total momentum is conserved, how will the total momentum after the collision compare to the total momentum before the collision?

CR#: 22

Learning Results: I-1

Motion

- I Students will understand the motion of objects and how forces can change that motion. Students will be able to
- 1 use mathematics to describe the law of conservation of momentum.

CONSTRUCTED-RESPONSE SCORING GUIDE

Score	Description
4	Student demonstrates thorough ability to use mathematics to describe the law of conservation of momentum. Response includes the momentum of object A before the collision, the total momentum before the collision, and the total momentum after the collision. Response contains no errors.
3	Response demonstrates broad ability to use mathematics to describe the law of conservation of momentum. Response contains one error.
2	Response demonstrates limited ability to use mathematics to describe the law of conservation of momentum. Response contains two errors.
1	Response demonstrates minimal ability to use mathematics to describe the law of conservation of momentum. Response contains three errors.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.
Blank	No response.

Training Notes for Constructed-Response #22

Score this item completely by points as follows:

1 point for the correct number **and** direction in part a.

1 point for the correct number **and** direction in part b.

1 point for the correct answer for part c.

1 point for the correct units (i.e., kg m/s **or** kg-m/s **or** Ns **or** N-s) used in **all** parts.

Note: A kilogram meter per second (kg m/s) is the same as a newton second (Ns).

Part a:

+8 kg m/s **or** 8 kg m/s

Part b:

−7 kg m/s

Part c:

The total momentum after would be the same as the total momentum before, **or**

−7 kg m/s **or**

whatever the student wrote for part b is also written for part c.

22.

4

- a. The momentum of object A is: $p = 2\text{Kg} \cdot 4 \text{ m/s} = 8 \text{ Kg} \cdot \text{m/s}$
 b. The momentum of object B is: $p = 3\text{Kg} \cdot -5 \text{ m/s} = -15 \text{ Kg} \cdot \text{m/s}$
 so the total momentum is the momentum of A + the momentum of B or: $8 \text{ Kg} \cdot \text{m/s} - 15 \text{ Kg} \cdot \text{m/s} = -7 \text{ Kg} \cdot \text{m/s}$
 c. The total momentum before the collision should be equal to the total momentum after the collision.

22.

4

- a. $p = 8 \text{ Kg} \cdot \text{m/s}$
 b. $p = -7 \text{ Kg} \cdot \text{m/s}$
 c. It is the same.

22.

3

a) The momentum of object A before the collision is 8 kg m/s . b) The total momentum of the two objects before the collision is 23 kg m/s . c) If it is conserved it will be the same after as it was before.

22.

3

a) The momentum of object A before the collision is $+8$. b) The total momentum of the two objects before the collision is -7 . c) If the total momentum is conserved The total momentum after the collision will be the same as the conserved amount.

22.

2

a.) the momentum of object A is : $2(4) = 8 \text{ m/s (east)}$.

b.) the total momentum of the two objects before the collision is -7 m/s (west) .

c.) If the total momentum is conserved, the total momentum before the collision would be greater than it would be after the collision. After the collision, the objects would not be moving as fast or at all, therefore lowering their momentums.

22.

2

The momentum of object A is 8. The total momentum is -7 .

22.

1

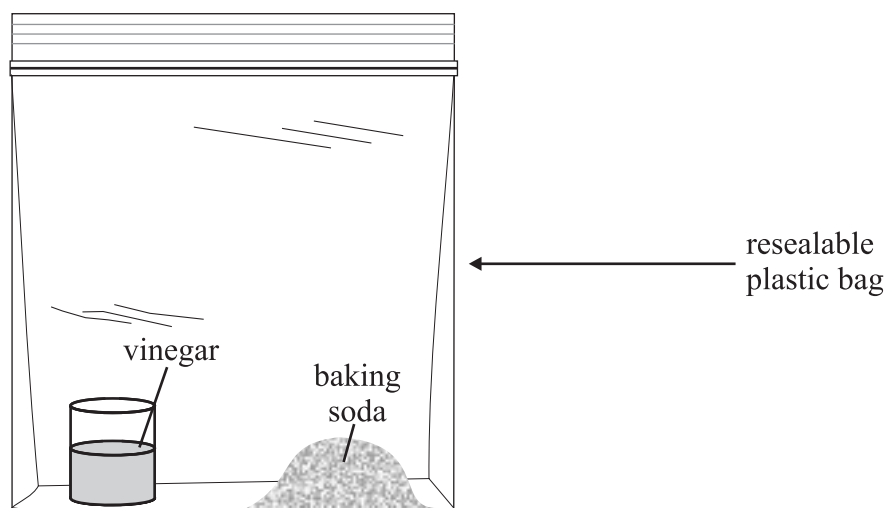
a. 8
b. 7

c. I would believe that there would be no momentum after the collision because the objects will be stopped.

22.

1

- a. The momentum of object A is $+4 \text{ m/s}$
- b. The total momentum is -1 m/s
- c. The momentum will remain the same.



23. A student places a container of vinegar into a resealable plastic bag with some baking soda. The bag is then sealed. The student determines the mass of the sealed system, and then the vinegar is allowed to mix with the baking soda.
- Describe what will happen when the mixing occurs.
 - How will the mass of the system after the reaction is complete compare with the initial mass of the system? Explain your answer.

CR#: 23

Learning Results: E-4

Structure of Matter

E Students will understand the structure of matter and the changes it can undergo. Students will be able to
4 describe an application of the Law of Conservation of Matter.

CONSTRUCTED-RESPONSE SCORING GUIDE

Score	Description
4	Response earns 4 points.
3	Response earns 3 points.
2	Response earns 2 points.
1	Response earns 1 point.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.
Blank	No response.

Training Notes for Constructed-Response #23

2 points for each part

a. A chemical reaction will occur. The vinegar and baking soda will react and give off gas. Evidence of this chemical reaction is the foaming and fizzing that occur. The sealed baggie will expand.

Notes:

1. The specific gas (carbon dioxide) does not need to be given. Therefore, a score should not be lowered if the response incorrectly identifies the gas (for example, calls it nitrogen).
2. A score should not be lowered if a response refers to a phase change (solid to gas), although strictly speaking this is incorrect.

b. Mass remains unchanged (the mass after the reaction will be the same as the mass before the reaction).

Mass remains constant because system is closed.

OR

Mass is conserved in chemical reactions (conservation of mass).

Notes:

1. Also accept for full credit an answer that claims some of the gas will get out of the bag and thus the mass will be less.
2. A common misconception is that the mass will become greater because of the gas being created (volume changes are incorrectly viewed as an increase in mass).

23.

4

- (a) When the mixing of the baking soda and vinegar occurs, there will be a chemical reaction between the two, and gas will be given off, as well as a lot of foam, and the bag will expand.
- (b) The mass of the system before and after the reaction will remain the same, taking into account that the bag stays closed and there are no holes in it. Although the matter inside the bag has gone through a chemical reaction as well as a physical reaction, by changing states from a liquid and solid into a gas, nothing has been lost from the bag, and the exact same amount of matter is still located inside the bag. The matter inside the bag did not exit the bag, and no new matter was created and no ~~new~~ matter was destroyed. The matter just changed. Although the bag will be ballooned up after the reaction and will take up more volume, it will ^{have the} same mass.

As the vinegar and the baking soda mix the react together and create a gas which will cause the volume of the resealable plastic bag to increase. When the bag can not grow any larger the pressure will build to a certain point. The mixing will leave a white solution of baking soda and vinegar in the bottom of the bag. The Mass of the system will not differ because all was sealed in the plastic bag. Even though there are not separate substances any more the bag didn't lose any mass.

a) When the mixing occurs between baking soda and vinegar, a chemical reaction occurs. The mixture starts to bubble and foam. The mass of the system will stay the same. This is due to the Law of Conservation of Mass, this is a scientific law that tells us that mass is neither created or destroyed in a chemical reaction.

1a) When the reaction occurs the two substances will combine to form new substances with one being a gas. The two original substances will not be able to reproduce from the experiment because it was a chemical reaction.

1b) The mass of the bag after the experiment is complete would be the same because the bag is sealed and none of the gas should escape. This is because of the law of conservation of mass which states that mass can neither be gained nor lost.

23.

2

a a chemical reaction between the vinegar & baking soda creates a large amount of gas which fills the bag & blows it up like a balloon.

b the mass will be much larger because the chemical reaction between the vinegar & baking soda produced gas which because the molecules are farther apart than in a solid & liquid creates a bigger mass.

23.

2

When these two elements are mixed, there will be a great deal of bubbling and fizzing! People will go 'ooh' and 'ahh!'. But the mass of the sealed system will not change. The vinegar, and acid, will mix with the base baking soda. Gases (CO_2) will be released and the bag will inflate as solid/liquid becomes gas. The little gas molecules will fly about, bouncing on the sides of the bag. That is what causes it to inflate, thus, increasing the mass. Depending on the amount of reagent used, will determine how much the mass will increase by. The number of 'Acho' and 'Boo's will also increase if the plastic bag should explode. Thus, introducing the mass factor A.K.A. Murphy's Law. ☺

23.

1

A. When the mixing occurs the vinegar on the baking Soda will cause it to bubble up and erupt, somewhat like a volcanic effect. I did this in the grade school but another then that I have not done this.

23.

1

A. The Vinegar will turn the baking soda into white bubbles.

B. Much more, because each of the bubbles take up more room than the vinegar and baking soda do.

24. In 1953, Stanley Miller and Harold Urey replicated conditions believed to have existed before life appeared on Earth. In a sealed glass container, methane, ammonia, water, and hydrogen were combined. This combination was exposed to heat and electric sparks. After one week, amino acids were found in the container.
- Discuss in detail how the results of this experiment support scientific theories on the origin of life on Earth.
 - Discuss in detail the limitations of this experiment in explaining how life arose on Earth.

CR#: 24

Learning Results: L-1

Communication

L Students will communicate effectively in the application of science and technology. Students will be able to
1 analyze research or other literature for accuracy in the design and findings of experiments.

CONSTRUCTED-RESPONSE SCORING GUIDE

Score	Description
4	Response discusses in detail how the experiment supports scientific origin of life theories and the limitations of the experiment. Response contains no errors.
3	Response discusses in detail how the experiment supports scientific origin of life theories and the limitations of the experiment. Response contains minor errors or lacks some detail.
2	Response discusses in detail how the experiment supports scientific origin of life theories. OR Response discusses in detail the limitations of the experiment. OR Response discusses how the experiment supports scientific origin of life theories and the limitations of the experiment. Response contains errors or lacks detail.
1	Response discusses how the experiment supports scientific origin of life theories or the limitations of the experiment. Response is minimal, contains errors, or lacks detail.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.
Blank	No response.

Training Notes for Constructed-Response #24

a. Support—Need at least 2 **or** 1 in great detail.

- Organic molecules necessary for life were produced by the experiment.
- Molecules necessary for life were produced from the inorganic molecules and simple organic molecules.
- Amino acids are found in proteins, which all living things contain.
- All living things contain the specific molecules produced by the experiments.
- In order for life to arise, these molecules would need to be present.

b. Limitations—Need at least **2**.

- The experiment did not actually produce life.
- The experiment did not produce all of the molecules necessary for life, only some of them.
- Does not prove life arose this way, only that it might have.
- Only one experiment, needs to be replicated.
- The conditions on Earth may have been different than what was used in this experiment.

Misconception: Most primitive organisms were viruses. Saying first amino acids became viruses is untrue.

24.

4

Scientists have hypothesized that inorganic substances, when exposed to the harsh conditions of the early earth, could reform and synthesize organic building blocks of life. The Miller/Urey experiment helped support this hypothesis by subjecting substances that are believed to be present in the Earth's infancy to forces (lightning, high temperatures from volcanoes) that were also active at that time to synthesize molecules fundamental to the development of life. However, this experiment lacked a control -- a serious flaw in any scientific experiment. Also, it does not explain how the complex molecular interactions involved in cells arose: It just explains that the molecules could have been produced. How these molecules came together and started interacting was not treated by this experiment.

a) The experiment shows that an element necessary for life, amino acids, can be produced under the conditions of Earth before life. Amino acids which form proteins are the building blocks of life that all living organisms possess. Since amino acids can be made from abiotic substances, methane, water, etc., it can be assumed that this may have been how life began. Theories that are scientifically based rather than the creationary, are supported by this experiment because it shows that life could have begun as a collection of amino acids formed coincidentally by elements of the prehistoric Earth.

b) The experiment may not take into account other chemicals/substances present on Earth at the time, substances included that may not have been present, specific conditions, and the scale of the experiment in comparison to Earth before life. Also, the coincidence of all these substances/energies coming together as they did in the experiment may not have occurred. Therefore, any inaccuracy or imperfection of the replication of Earth before life may have caused the amino acids to form and the results would be less consequential.

a. The results of this experiment support scientific theories of the origin of life because these amino acids are building blocks of protein which makes up the outer membrane of viruses, the earliest forms of life. With the amino acids, viruses could have been created which later evolved in more complex organisms.

b. This experiment had limitations because it didn't involve other factors of the earth such as the rocks, water, and weather conditions which existed when earth had no life and the test tube environment was not extremely reflective of what actually happened because boiling water and electrical current from wires were not involved in the real process.

- a) This experiment supports the theories of the origins of life by showing that proteins can be produced with enough heat and energy. Proteins are a necessity for life and by showing that amino acids can be produced using fairly common substances, it also shows that microscopic organisms could also form; leading to the formation of animals and humans.
- b) However, this was a controlled experiment meaning the heat remained constant and the substances were measured. In "real life" before life, these conditions could have varied a bit. For example the temperature could have changed, even if it was only 2° difference. This could have produced a different result in the laboratory. Also the amount of each substance could have been different than those in the laboratory.

24.

2

A. This experiment shows that it is possible for organic compounds to be produced simply by introducing an electric charge to these gases. This supports the scientists theory because those compounds when further combined produce proteins which are the basis of cell structure.

B. It only demonstrates the first step, and also, it requires specific conditions. How are we to know these conditions existed?

24.

2

A) This experiment supported life on Earth evolution theories by proving that if only a few basic, naturally occurring elements were combined then parts of living organisms could be produced. It then stands to reason that it could be done to make living creatures if done a certain way.

B) This experiment only proved amino acids could be produced and gave no solid proof that actual living being could be produced. This experiment did not include many variable that could produce different results (ie. sunlight, etc.) there are is limited in it's results.

24.

1

a. AMINO ACIDS ARE IMPORTANT IN THE SURVIVAL OF HUMANS SO THIS EXPERIMENT DOES SUPPORT THE THEORY OF ORIGIN OF LIFE.

b. BUT, AMINO ACIDS ARE ONLY PART OF HUMAN LIFE. THERE WERE OTHER THINGS AROUND (LIKE OXYGEN) LONG BEFORE HUMANS EVOLVED.

24.

1

a) These results support scientific theories about the origin of life on Earth. They support these theories in that amino acids are a building block for life. This experiment also confirms that you need to have water in order for life to exist.

b) The limitations of this experiment on how life arose on Earth include that nowhere in this experiment is oxygen. Oxygen is needed for life but is not involved in this experiment. This experiment also does not really explain what the use of electricity has to do with life on Earth.

25. Which device was necessary for the Industrial Revolution?
- A. microscope
 - B. telescope
 - C. steam engine
 - D. navigational compass

MC#: 25

Key: C

Learning Results: M-3

Implications of Science and Technology

- M Students will understand the historical, social, economic, environmental, and ethical implications of science and technology. Students will be able to
- 3 evaluate the ethical use or introduction of new scientific or technological developments.

26. Sound travels through the air by
- A. mutual gravitational attraction between molecules.
 - B. repulsion between electrically charged molecules.
 - C. random motion of molecules.
 - D. regular vibration of molecules.

MC#: 26

Key: D

Learning Results: H-3

Energy

H Students will understand concepts of energy. Students will be able to
3 explain or demonstrate how sound waves travel.

27. Which will increase as a material is heated and a change in temperature occurs?
- A. the kinetic energy of its molecules
 - B. the potential energy of its molecules
 - C. the charge of its molecules
 - D. the mass of its molecules

MC#: 27

Key: A

Learning Results: I-5

Motion

- I Students will understand the motion of objects and how forces can change that motion. Students will be able to
- 5 explain the relationship between temperature, heat, and molecular motion.

28. Objects in space known as quasars are observed moving away from Earth. Which statement explains this observation?
- A. The universe is very big.
 - B. The universe is expanding.
 - C. Earth revolves around the Sun.
 - D. Earth rotates on its axis.

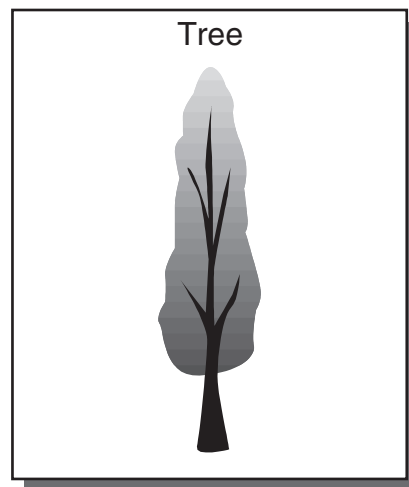
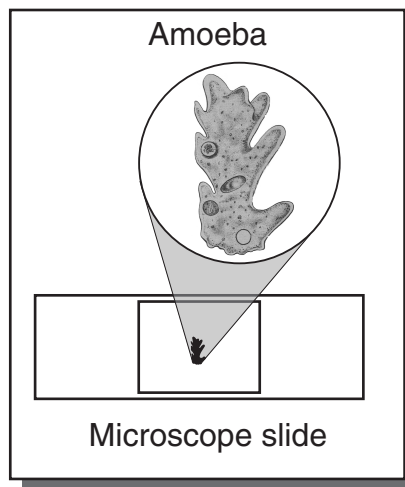
MC#: 28

Key: B

Learning Results: G-2

The Universe

- G Students will gain knowledge about the universe and how humans have learned about it, and about the principles upon which it operates. Students will be able to
- 2 research current explanations for phenomena such as black holes and quasars.



40. All living things have certain characteristics in common. Identify **four** of these characteristics and describe a way in which the amoeba and the tree differ with respect to each characteristic.

CR#: 40

Learning Results: A-3

Classifying Life Forms

- A Students will understand that there are similarities within the diversity of all living things. Students will be able to
- 3 analyze the basic characteristics of living things, including their need for food, water, and gases and the ability to reproduce.

CONSTRUCTED-RESPONSE SCORING GUIDE

Score	Description
4	Student demonstrates thorough understanding of the basic characteristics of living things. Response includes four characteristics of living things and describes a way the amoeba and the tree differ with respect to each characteristic. Response contains no errors.
3	Student demonstrates general understanding of the basic characteristics of living things. Response includes at least three characteristics of living things and describes a way the amoeba and the tree differ with respect to each characteristic. Response contains minor errors or omissions.
2	Student demonstrates limited understanding of the basic characteristics of living things. Response includes at least two characteristics of living things and partially describes a way the amoeba and the tree differ with respect to the characteristics. Response contains major errors or omissions.
1	Student demonstrates little understanding of the basic characteristics of living things. Response includes a characteristic of living things and minimally describes a way the amoeba and the tree differ with respect to the characteristics. OR Response simply lists three or four characteristics of living things.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.
Blank	No response.

Training Notes for Constructed-Response #40

1. **composed of cells**—amoeba is single cell with no chloroplasts or cell wall, while tree is multicellular [more specialized cells] with chloroplasts and cell walls
2. **grow and develop**—amoeba grows only a small amount, while tree grows very large; amoeba cells don't differentiate, while tree cells do differentiate
3. **reproduce**—amoeba asexual (fission), while tree sexual (seeds)
4. **need food**—amoeba relies on other organisms for getting sugar, while tree makes its own sugar
5. **need water**—amoeba takes in water through any part of its cell membrane, while tree takes in water through its roots
6. **response to stimuli/movement**—amoeba can move across a surface, while tree is relatively stationary
7. **ability to repair itself/adapt**—an amoeba is somewhat limited since it is a single cell, but tree can still live if a branch is broken
8. **use of gases**—the amoeba cannot use carbon dioxide, but the tree uses carbon dioxide to make sugar
9. **needs nourishment**—amoeba directly ingests food, tree produces its nourishment through photosynthesis
10. **excretes waste products**—amoeba has direct elimination through cell membrane, tree releases O₂ through stomata
11. **have a life cycle and die**—the amoeba has a short life cycle; the tree has a longer life cycle of many seasons

Special Note to Scorers: A response that simply lists four characteristics is only worth **one** point, not two points as we usually do. The reason is that a list could be generated by elementary school students—a list is not at the level of “analyze” stated in the high school performance level indicator 5.1.63.

40.

4

Four characteristics that all living things have in common are: all living things are made of cells, all living things need energy to survive, all living things reproduce, and all living things have a niche in an environment. An amoeba is made up of only one cell, while a tree is made up of many cells. Trees obtain their energy through photosynthesis and amoebas get their energy from other organisms. A tree reproduces sexually through pollen and amoebas reproduce asexually. A tree's niche is to produce oxygen and energy while an amoeba's niche is to take care of other population of microscopic organisms.

All living things have cells, a kind of respiration, a kind of reproducing, and also their own kind of habitat. The tree and amoeba differ in some ways and are also alike in other ways. The tree and amoeba both have cells. The amoeba is one cell while the tree is multi-cellular. The cells both have ways of obtaining energy, and use respiration for the energy. The tree reproduces by seeds, and the amoeba reproduces asexually. Also the tree and amoeba have different habitats. One is ^{planted} in the ground while the other lives in or around water.

40.

3

Trees and amoebas have much in common. Both respire; trees take in CO_2 and release O_2 , while amoebas intake O_2 and exhale CO_2 . Both need light to survive—trees in order to perform photosynthesis and amoebas need sunlight to help feed the plant-based organisms that they feed on. Both need food for energy—the tree uses sunlight to make sugar, while the amoeba hunts for living things to eat. Finally, both have lifespans. Trees will eventually be struck by lightning, cut down or run out of nutrients. Because the amoeba reproduces sexually, it also will die someday when its components become too old to function or it has trouble finding food.

40.

3

The tree and amoeba are made of cells. They breathe, eat, and reproduce. Trees do each thing differently, though. A tree breathes by taking in carbon dioxide and putting out oxygen. Amoebas have cellular respiration. Trees eat through photosynthesis. Amoebas reproduce by splitting and trees produce seeds to reproduce.

40.

2

The tree and the amoeba, both are made up of cells and are living things. They both use some form of photosynthesis or cellular respiration to survive. An amoeba may move around but a tree cannot and the amoeba may take on different shapes while the tree pretty much has a standard shape.

40.

2

1.) The amoeba is made up of a nucleus and other cell parts, and so is the tree, but the tree is made up of many while the amoeba is single celled. 2.) The tree and amoeba live from balanced nourishment, but the tree will live longer because it can lose one cell and regenerate while the amoeba only has one life. 3.) The amoeba consumes its food, but the tree uses photosynthesis. Both however use the chemical reactions to live. 4.) Both need specific climates to live, but the tree can adapt to them easier.

40.

1

They are both living, capable of reproduction they both have nucleuses, both cells stay at a equilibrium to stay alive.

40.

1

Both the amoeba and the tree grow. The amoeba may grow larger and the tree will grow taller. The amoeba can engulf its food while a tree absorbs its food through the roots. Both an amoeba and a tree respire. Probably both from the cells. An amoeba will die after its life cycle, as will a tree.

41. The theory of plate tectonics states that the continents move as part of crustal plates. Based on this statement, make **three** predictions of how Earth will look different in 50 million years and give a scientific explanation for each of your predictions.

CR#: 41

Learning Results: J-2

Inquiry and Problem Solving

- J Students will apply inquiry and problem-solving approaches in science and technology. Students will be able to
- 2 verify, evaluate, and use results in a purposeful way. This includes analyzing and interpreting data, making predictions based on observed patterns, testing solutions against the original problem conditions, and formulating additional questions.

CONSTRUCTED-RESPONSE SCORING GUIDE

Score	Description
4	Response demonstrates a thorough ability to make predictions about how Earth will change. Response includes three plausible predictions with a detailed scientific explanation for each.
3	Response demonstrates a general ability to make predictions about how Earth will change. Response includes two or three plausible predictions with scientific explanations. Response lacks some detail or contains minor errors.
2	Response demonstrates a limited ability to make predictions about how Earth will change. Response includes plausible predictions with partial scientific explanations or simply lists three plausible predictions. Response contains errors or fails to address some aspects.
1	Response demonstrates little ability to make predictions about how Earth will change. Response is minimal, but includes a plausible prediction.
0	Response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.
Blank	No response.

Training Notes for Constructed-Response #41

Possible Predictions:

Continents will be different shapes, sizes, and in different locations.

Atlantic Ocean will be larger.

A new sea floor will be created.

Himalayas and Alps mountain ranges will be higher.

Africa will split along the Great Rift Valley and form a new sea.

Africa will move into Europe (reducing the Mediterranean Sea).

California will detach and move northward.

Note: More general predictions may also be acceptable.

Possible Explanations:

Explanations will likely be in terms of the plates that the continents ride on. The explanations should be scientific and plausible, although they do not need to match what a scientist would claim.

Explanation may include references to asthenosphere, convection cycle, sliding, and diverging/converging boundaries.

Note: Different predictions may have the same explanation.

41.

4

a) California may no longer be connected to the mainland of North America (if indeed it's still California in 50 million years). This would be due to the large fault line (where two plates rub together) between California and the large plates of the rest of the continent. b) ^{western}Europe and the Eastern U.S. could be farther apart, since they lie on separate plates which are moving slowly away from each other. c) Western U.S. and Eastern Asia could eventually collide due to continental drift, and also would look a great deal different (for example, South America might very well "hang" from N. America at a different angle, as they're separated by only the small land mass of Central America and both on different plates).

The theory of plate tectonics states that the continents move as part of crustal plates. In 50 million years, the Earth will look very different; here are some predictions.

The Pacific Ocean will be significantly smaller. The continent of North America (the tectonic plates) are moving into the Pacific Ocean a miniscule amount each year, as the years progress, our Pacific Ocean is going to get smaller and smaller.

The Atlantic Ocean will be much bigger than it is now. Due to the mid Atlantic ridge that is continuously creating more plates underwater, Africa is being pushed eastward and N. America westward. Thus, over time, it will grow.

Thirdly, more islands, volcanic spots, unknown to us now, will have been created. Over thousands of years, such islands and volcanic areas are created due to plate movement and "hot spots."

41.

3

Recent research has shown that North and South America are moving west as the plates on which they rest move in that direction. Hence in fifty million years the Atlantic Ocean will be larger and the Pacific Ocean much smaller. Also, some lands will crash into each other, creating different land masses from the ones we're used to today and also new mountain chains; when two masses of earth crunch together, they push up land where they meet, just as the Himalayas were created when India crashed into Asia.

41.

3

- ① There will be many more island chains → As the plates slip underneath each other, magma is forced up by the action of volcanoes.
- ② California will be an island → California is on a different tectonic plate than the rest of the U.S. These two plates are diverging along the San Andreas fault.
- ③ The Himalayas will continue to get taller → The plates which compose Asia, the Middle East, and India are all converging, building the Himalayas. This trend will probably continue, forcing the converging land masses higher in altitude, as they have nowhere else to go.

Because scientists believed that the Earth contained one large continent millions of years ago, and then separated, I think the continents will continue to move. Eventually, instead of the Atlantic being in the center, Asia and North America will meet on the other side of the Earth, forming one large continent again. With this, the ocean floor will change and the Atlantic will become very deep. It will be prone to earthquakes due to thin crust and the large continent will break again and form all new continents again.

The earth is made up of about 12 large tectonic plates, on which the continents are located. As the plates move and shift, the continents on them will change as well.

One prediction I have for the appearance of earth in 50 million years is the following:

Where two of these plates rub together, such as in California (the Atlantic and Pacific plates) with the San Andreas fault, the western half of California will be located much farther north, with the moving Pacific plate. Scientists also say that Mount Everest is getting larger, so in 50 million years that mountain will be extremely large (if it doesn't crumble under its own weight).

A second prediction I have is that by 50 million years from now, the plates will have all met in such a way that all of the land still above water will be in one large group. 3rd prediction: No land left, all water due to drop-slip fault.

41.

1

I think they will just keep splitting apart further and further till they hit each other.

They will hit and cause a huge earth quake.

Then will stay the same nothing will change

41.

1

I think that the earth's continents will be closer together because the plates will shift them closer together.